

**MOTOROLA**

Disclosure for Patent Committee Review
Submitted Pursuant to Employee Agreement

DISCLOSURE TYPE:

**SHORT
FORM**

☒

When using the short form (single page), the review committee may request additional information before reaching a decision.

**EXPANDED
FORM**

☐

Use additional pages in the expanded form if you feel more information will be necessary for the committee to reach a decision.

Disclosure <i>1365 I</i>	Date <i>[Redacted]</i>
Division <i>Corp. Manuf.</i>	
Patent Committee <i>Mfg. Sci.</i>	

- Title of Invention:** Reflective Liquid Crystal Displays with Photo-voltaic Element as the Replacement for back Absorber

1a. Key Words: Cholesteric LCD, PDLC, solar cells, back absorber
- Primary or contact point inventor(s)** Use your full first, middle, and last names. Use page 2 of the expanded disclosure form for contributing inventors.

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3. What was the problem(s) to be solved by the invention or what was the need(s) for the invention:

Portable products, such as cellular phones, PDA and pagers, that use low battery energy are of great interest for Motorola. One way to extend battery life is to increase the energy supply. An alternative method is to reduce the power consumption. This invention addresses the third approach: utilization of otherwise wasted light (solar) energy, converting it to electric energy as a supplemental source through the proper combination of display in use and the solar cell.

4. What is the prior art, and why doesn't it resolve the problem(s) or fulfill the need(s):

The use of solar cells as a power source on low power portable devices is well known, such as in the case of the pocket size calculator. In prior art, the light collecting surface of the solar cell and the display are placed side by side. Two recent patents (in 1996) have been found that the display and the solar cell are in stacked arrangement. The first is a transmissive type LCD that uses an always-on backlight as its illumination. The other is a reflective type of display using a hologram reflector as a replacement for a conventional reflector.

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5. What is the invention being disclosed:

This invention consists of reflective (monochrome or color) liquid crystal display that does not require a separated reflective element such as various reflectors; and a solar cell in a tandem (stacked) arrangement. In this invention, the solar cell is placed immediately behind the liquid crystal cell. The display itself does not require a separate reflector; in other word, there will be no other reflective component between the back of the LC cell and the front of the solar cell. The absence of the reflector will insure that large percentage of incoming ambient light will pass through the display and impinge upon on the solar cell to increase the usefulness of the solar cell as a supplemental energy source. In particular, this combination can be applied to choelsteric liquid crystal display or Polymer Dispersed Liquid Crystal Display; both are free of reflector, by replacing the back absorber in the prior art with a solar cell.

6. How does this invention resolve the problem(s) and fulfill the need(s) in a new way: Attach any drawings or diagrams you feel are necessary for clarification.

Reflective liquid crystal displays on the market use a separate reflector to redirect the incoming ambient light to human eyes to form visual image. This reflector in combination with other lossy elements in the current structure such as color filter and polarizer cuts the light level after the reflector to a negligible amount (~ 1%) for any meaningful reuse of that part of the light energy. On the other hand, for the display technologies that do not require the back reflector, such as cholesteric and PDLC, a substantial amount (> 75% in some cases) light will pass the display. A black absorber has to be placed on the rear surface of the display to collect this passed light energy for the quality image. By replacing this absorber with a solar cell, based on our model, a sizable energy as compared with the standard LiH battery can be collected. Depending on user model, electrical energy in the range of 20 – 40 % of the total StarTac battery energy has been shown by our model for single color cholesteric liquid crystal display, on the contrary, less than 2 % could be collected if using the display with a reflector.

7. Date of Conception: _____ and if applicable, date first built (or written) and successfully tested: _____

8. Product(s) this invention may be used in:

9. Date the first offer for sale was made for a product incorporating this invention: _____ N/A

10. Date the first disclosure of this invention was made outside Motorola without a nondisclosure agreement: _____ N/A

11. Approvals: 1) Technical Staff or Patent Liaison; 2) Management (both required). Signing this form attests to the fact that you understand the invention.

	Name / Signature	Dept. No.	Location/Room #	Phone Number
1)	_____	_____	_____	_____
2)	_____	_____	_____	_____

12. Witnesses:

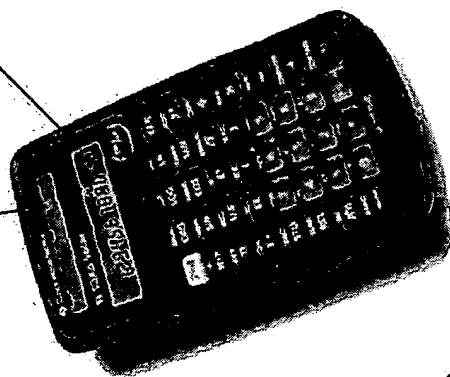
Witness: _____ Date: _____ Witness: _____ Date: _____



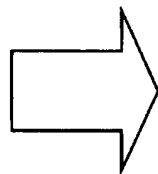
Prior Art

Solar cell

Display



Side by Side



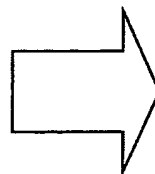
Stacked



< 1% of Incoming

Solar cell location

This Invention



75% of Incoming

Black Absorber



Ch-LCD



75% of Incoming

Solar cell location

MATC Display Technologies Lab.

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Solar cell behind Reflective LCD panel as supplemental energy source

	Solar Cell1(A52,169)	Solar Cell2(A35,437)	Solar Cell3(A37,339)
Solar Cell Parameters			
Full Sun	10 V 9 mA 90 mW	20 V 250 mA 5000 mW	0.5 V 250 mA 125 mW
Indoor Light	0.603 mW	33.5 mW	0.8375 mW
Panel Size	1.5 in L 2.5 in W	7 in L 8 in W	0.79 in L 1.57 in W
Panel Area	3.75 sq.in.	56 sq.in.	1.2403 sq.in.
Thickness	1.6 mm	6.35 mm with frame	0.2 mm
Weight		1.2 gram/sq.in.	
\$/sq.in retail			
Power Output/sq.in			
TN or STN	0.05		
Ch-LCD			
mono or ETC	0.74		
Full sun	17.76 mW/sq.in	66.07143 mW/sq.in	74.57873 mW/sq.in
Indoor Light	0.118992 mW/sq.in	0.442679 mW/sq.in	0.499677 mW/sq.in
Energy Generation			
Use Model 1: Typical user, MAP 5.2 sq.in	5.2		
0.2 full sun ?			
Out dr/day	2 hour 132.9869 J	494.7429 J	558.4455 J
Indoor/day	10 hour 22.2753 J	82.86943 J	93.53963 J
Bat. Life	3 day		
Total	465.7865 J	1732.837 J	1955.955 J
Solar Battery Energy			
Solar Battery Energy			
TN or STN	0.511242 %	1.901942 %	2.146835 %
Use Model 2: On the road, MAP 5.2 sq.in			
0.2 full sun ?			
Out dr/day	4 hour 265.9738 J	989.4857 J	1116.891 J
Indoor/day	15 hour 33.41295 J	124.3041 J	140.3094 J
Bat. Life	2 day		
Total	598.7734 J	2227.58 J	2514.401 J
Solar Battery Energy			
Solar Battery Energy			
Added on weight			
Added on weight			
TN or STN			

Energy Efficiency Comparison

	by weight		by cost	
	Use model 1	Use model 2	Use model 1	Use model 2
Solar cell	277.6982 J/g	356.9839 J/g	116.6697 J/\$	149.9801 J/\$
Extended battery	165.0402 J/g	165.0402 J/g	61.56 J/\$	165.0402 J/\$

Note:

a) StarTac battery life: [redacted] (Note: [redacted])

b) Power consumptions

	Standby	Active
MAP	05 Hrs	10 min
StarTac	100 Hrs	100 Min

c) StarTac Battery price

	Whole sale	Retail
Standard		
Extended		

d) StarTac battery weight Basic: 37.3 grams w/o case
44.9 grams with case

e) Power conversion from full sun to indoor based on the A52,162 at 150x

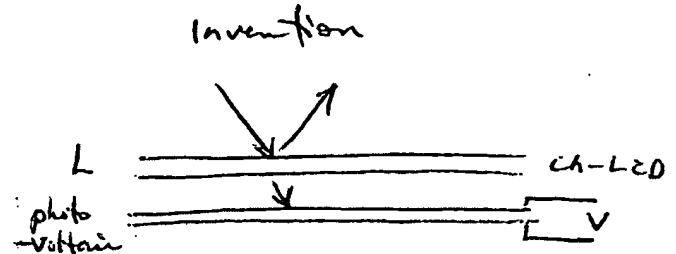
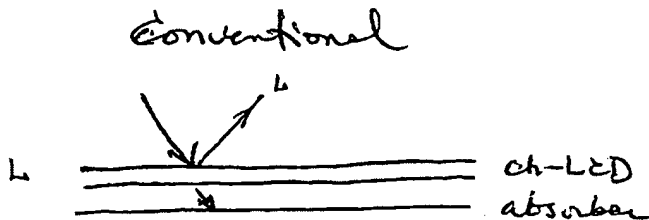
TITLE	MODEL
Cholesteric LCD with Photo-voltaic Element As Back Absorber.	

Absorber.

Problem: The cholesteric LCD use selective reflection in stead of absorption. At least 50% incoming light ~~passed~~ passes the display & this portion of light is being absorbed by a ~~an~~ absorber affixed to the back of ch-LCD.

Solution: This invention is consists of a new structure in which the conventional, lossy absorber is replaced by a Photo-voltaic element. The element will convert the otherwise being absorbed \rightarrow heat ~~and~~ light energy to electrical energy that can be used as power supply for the portable product.

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For portable product such as pager or cellphone. This can be a supplementary source for power

